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Agricultural Memorandum No 947

Long Term Irrigation Planning - The Computer Program Approach

by M. Field

1. Introduction

The cost of installing an irrigation system on a moderate size farm is likely to be in the order of several tens of thousands of pounds. Careful planning is clearly required with an investment of this size.

For a first look at the irrigation need of a farm one can use either the Atlas of Long Term Irrigation Needs for England and Wales (W H Hogg, 1967) or Appendix 1 of MAFF Reference Book 138 in conjunction with MAFF Technical Bulletin 35; these methods are quick and easy to use. For a more detailed investigation the Irrigation Planning Program should be used. This has the advantages of greater versatility and accuracy. The Program 'runs' an irrigation plan for a particular farm using stored meteorological data for a period of about 20 years. The water requirements in both the long and short term are calculated.

2. How the Irrigation Planning Program is Used

The Program is run by an agrometeorologist at the Meteorological Office HQ at Bracknell in close collaboration with the farmer's ADAS Adviser,

(i) an Adviser visits the farm and obtains the input data (location, soil type, crop rotation, field sizes, etc.),

(ii) an Irrigation Plan for the farm is drawn up,

(iii) the Program is run to assess the water requirements of the farm,

(iv) an irrigation system is designed with the help of ADAS Advisers,

(v) the cost of the system is evaluated.

If the cost is unacceptable or the water requirements cannot be met the irrigation plan is revised and stages (iii) to (v) are repeated. The Program can be re-run until such time as a system is designed which meets the farmer's requirements.

3. The Information Provided by the Program

The farm is divided up into a number of fields. The Program provides the following information for each field in turn,

(i) the dates on which water was required and the amount applied (in mm),

(ii) a year-by-year breakdown of -

(a) the total water required,

(b) the number of applications in the year,

(c) the dates of the first and last applications,

(d) the minimum period (in days) between successive applications,

(e) run off from April - September

(iii) the number of times a given period between applications occurs, ie a frequency distribution of the application interval (this is supplied for each year in turn),

(iv) monthly totals of the water requirement,

(v) yearly totals of the water requirement.

Appendix II gives the full computer output generated by the Program.

4. Input Data required to run the Program

The geographical location of the farm is required, preferably the Ordnance Survey grid reference. The following data are supplied for each field in turn on the farm, for up to a maximum of 14 fields,

(I) the size of the field (in Ha),

(II) the soil type (in one of three classes corresponding to low, medium or high available water capacity),

(III) the crop(s) that are grown in the field. Often there will be one crop but there can be from 2 to 5 crops in rotation. For each crop estimates are required of,

(i) the planting/sowing date, the date of $\frac{1}{4}$-cover, the date of $\frac{3}{4}$-cover, the date of senescence or harvest,

(ii) the 'irrigation plan'. This is in a number of 'stages'. Each 'stage' is of the form:

(a) date on which irrigation commences,

(b) SMD at which water is applied,

(c) amount of water applied when threshold SMD is reached,

(d) date on which irrigation ends.

The user supplies the number of irrigation stages (up to a maximum of 5) that are required to describe the irrigation plan for the crop. Often one stage is sufficient (see Appendix 1 for examples).

Appendix I gives an example of the input data for a hypothetical farm.

5. References

(i) MAFF/ADAS Reference Book 138 'Irrigation' (formerly Bulletin 138), published by HMSO.

(ii) A new Approach to Long Term Irrigation Planning, by R J Adams. Agricultural Memorandum No 853 (March 1979).

(iii) Atlas of Long Term Irrigation Needs for England and Wales, W H Hogg, MAFF (1967).

(iv) MAFF Technical Bulletin 35 'The Agricultural Climate of England and Wales', L P Smith (1976).

Any comments or suggestions on this paper should be referred to the author.

Meteorological Office, Met O 8a
Bracknell

October 1982

Appendix I - Input Data for a Hypothetical Farm

Location: Sleaford, Grid Ref = TF(08,45)

Number of fields: 2

Field 1 Area: 25 Ha Soil: Medium AWC

Crops: 2 crops in rotation (Earlies followed by Carrots)

(a) Earlies

sow	: 10/3
$\frac{1}{4}$-cover	: 12/4
$\frac{3}{4}$-cover	: 25/4
senescence/harvest	: 20/6

Irrigation plan (1 stage) apply 10 mm when SMD = 15 mm from 1/4 to 1/6

(b) Carrots

sow	: 25/6
$\frac{1}{4}$-cover	: 10/7
$\frac{3}{4}$-cover	: 25/7
senescence/harvest	: 15/11

Irrigation plan (1 stage) apply 25 mm when SMD = 35 mm from 10/7 to 30/9

Field 2 Area: 10 Ha Soil: High AWC

Crops: Sugar beet (no rotation)

(a) Sugar Beet

sow	: 10/4
$\frac{1}{4}$-cover	: 12/5
$\frac{3}{4}$-cover	: 15/6
senescence/harvest	: 30/9

Irrigation plan (3 stages)

Stage 1 Apply 25 mm when SMD = 30 mm from 1/5 to 30/6
Stage 2 Apply 25 mm when SMD = 40 mm from 1/7 to 31/7
Stage 3 Apply 50 mm when SMD = 65 mm from 1/8 to 31/8

AGROMET DATA AT CRANWELL
AGROMET DATA AT SUTTON BONNINGTON
AGROMET DATA AT FINNINGLY

Appendix II — Computer Output

The 1st part of the output consists of a summary of the input data

FARM DATA FOR ILLUSTRATING WRITE-UP OF IRRIGATION PLANNING PROGRAM.

(MORECS 40KM. GRID SQUARE NO.=108)

ANNUAL RAINFALL AT MET.STATION(1941-70 AVE.)= 600.0 MM
ANNUAL RAINFALL AT FARM (1941-70 AVE.)= 600.0 MM

	JAN	FEB	MAR	APRIL	MAY	JUNE	JLY	AUG	SEPT	OCT	NOV	DEC	TOTAL
AVERAGE RAINFALL ESTIMATED AT FARM OVER PERIOD 1961-1980(IN MM.)	47	38	43	46	48	52	49	63	47	41	55	51	580

	JAN	FEB	MAR	APRIL	MAY	JUNE	JLY	AUG	SEPT	OCT	NOV	DEC
AVERAGE POTENTIAL TRANSPIRATION AT FARM OVER PERIOD 1961-1980(IN MM.)	10	13	28	51	77	95	94	80	56	26	16	11

FIELD BY HEN HOUSE — AREA= 25.0 HA — SOIL TYPE IS B

FIRST EARLIES	10/ 3 : CROP IS SOWN
	12/ 4 : HALF-COVER CALCULATION COMMENCES
(PT FACTOR=1.00)	25/ 4 : FULL-COVER CALCULATION COMMENCES
(ROOT CONST.=50.0 MM)	20/ 6 : SENESCENCE/HARVEST

IRRIGATION STAGE 1.APPLY 10 MM AT 15 MM SMD BETWEEN 1/ 4 AND 10/ 6

CARROTS	25/ 6 : CROP IS SOWN
	10/ 7 : HALF-COVER CALCULATION COMMENCES
(PT FACTOR=1.00)	25/ 7 : FULL-COVER CALCULATION COMMENCES
(ROOT CONST.=50.0 MM)	15/11 : SENESCENCE/HARVEST

IRRIGATION STAGE 1.APPLY 25 MM AT 35 MM SMD BETWEEN 10/ 7 AND 30/ 9

FIELD BY DUCK POND — AREA= 10.0 HA — SOIL TYPE IS C

SUGAR BEET	10/ 4 : CROP IS SOWN
	12/ 5 : HALF-COVER CALCULATION COMMENCES
(PT FACTOR=0.95)	15/ 6 : FULL-COVER CALCULATION COMMENCES
(ROOT CONST.=60.0 MM)	30/ 9 : SENESCENCE/HARVEST

IRRIGATION STAGE 1.APPLY 25 MM AT 30 MM SMD BETWEEN 1/ 5 AND 30/ 6

IRRIGATION STAGE 2.APPLY 25 MM AT 40 MM SMD BETWEEN 1/ 7 AND 31/ 7
IRRIGATION STAGE 3.APPLY 50 MM AT 65 MM SMD BETWEEN 1/ 8 AND 31/ 8

FIELD BY HEN HOUSE

YEAR	TOTAL WATER(MM)	TOTAL WATER(ML)	FIRST APPLICATION	LAST APPLICATION	NO.OF APPLICATIONS	MIN.PERIOD(DAYS)	CROP	RUN OFF(MM) APR TO SEPT
1961	140	35.00	10/ 5	31/ 8	11	2	FIRST EARLIES CARROTS	32
1962	130	32.50	29/ 4	2/ 8	10	2	FIRST EARLIES CARROTS	31
1963	150	37.50	27/ 4	1/ 8	12	2	FIRST EARLIES CARROTS	78
1964	205	51.25	5/ 5	19/ 9	13	3	FIRST EARLIES CARROTS	9
1965	95	23.75	6/ 4	8/ 8	8	2	FIRST EARLIES CARROTS	77
1966	115	28.75	29/ 4	18/ 9	10	2	FIRST EARLIES CARROTS	62
1967	150	37.50	1/ 4	16/ 9	9	3	FIRST EARLIES CARROTS	82
1968	105	26.25	2/ 4	4/ 8	9	3	FIRST EARLIES CARROTS	217
1969	105	26.25	19/ 4	22/ 9	6	2	FIRST EARLIES CARROTS	89
1970	230	57.50	24/ 4	26/ 9	17	2	FIRST EARLIES CARROTS	65
1971	180	45.00	14/ 4	12/ 9	12	3	FIRST EARLIES CARROTS	77
1972	130	32.50	23/ 4	4/ 9	7	9	FIRST EARLIES CARROTS	45
1973	135	33.75	15/ 4	4/ 9	9	3	FIRST EARLIES CARROTS	78
1974	150	37.50	8/ 4	23/ 8	12	2	FIRST EARLIES CARROTS	45
1975	200	50.00	6/ 5	4/ 9	11	3	FIRST EARLIES CARROTS	35
1976	275	68.75	10/ 4	8/ 9	17	2	FIRST EARLIES CARROTS	68
1977	130	32.50	15/ 4	17/ 9	10	2	FIRST EARLIES CARROTS	20
1978	120	30.00	17/ 5	17/ 9	9	2	FIRST EARLIES CARROTS	98
1979	175	43.75	21/ 4	16/ 9	10	3	FIRST EARLIES CARROTS	76
1980	185	46.25	13/ 4	14/ 9	14	2	FIRST EARLIES CARROTS	100

Year by year breakdown of (a) to (e) (see Section 3(ii))

FIELD BY HEN HOUSE

APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OTHER
	10/ 5/61 10MM. 13/ 5/61 10MM. 17/ 5/61 10MM. 21/ 5/61 10MM. 24/ 5/61 10MM. 29/ 5/61 10MM.	3/ 6/61 10MM. 5/ 6/61 10MM. 9/ 6/61 10MM.	29/ 7/61 25MM.	31/ 8/61 25MM.		
*29/ 4/62 10MM.	7/ 5/62 10MM. 12/ 5/62 10MM. 17/ 5/62 10MM. 30/ 5/62 10MM.	2/ 6/62 10MM. 6/ 6/62 10MM. 8/ 6/62 10MM.	10/ 7/62 25MM.	2/ 8/62 25MM.		
*27/ 4/63 10MM.	4/ 5/63 10MM. 7/ 5/63 10MM. 17/ 5/63 10MM. 21/ 5/63 10MM. 28/ 5/63 10MM. 31/ 5/63 10MM.	4/ 6/63 10MM. 7/ 6/63 10MM. 9/ 6/63 10MM.	25/ 7/63 25MM.	1/ 8/63 25MM.		
	5/ 5/64 10MM. 9/ 5/64 10MM. 12/ 5/64 10MM. 15/ 5/64 10MM. 18/ 5/64 10MM. 23/ 5/64 10MM. 26/ 5/64 10MM. 29/ 5/64 10MM.		24/ 7/64 25MM.	3/ 8/64 25MM. 29/ 8/64 25MM.	7/ 9/64 25MM. 19/ 9/64 25MM.	
6/ 4/65 10MM.	11/ 5/65 10MM. 13/ 5/65 10MM. 21/ 5/65 10MM. 24/ 5/65 10MM. 31/ 5/65 10MM.	4/ 6/65 10MM.		8/ 8/65 25MM.		
*29/ 4/66 10MM.	2/ 5/66 10MM. 16/ 5/66 10MM. 23/ 5/66 10MM. 29/ 5/66 10MM. 31/ 5/66 10MM.	3/ 6/66 10MM. 7/ 6/66 10MM. 10/ 6/66 10MM.			18/ 9/66 25MM.	
1/ 4/67 10MM. *19/ 4/67 10MM.		2/ 6/67 10MM. 6/ 6/67 10MM. 9/ 6/67 10MM.	16/ 7/67 25MM. 30/ 7/67 25MM.	30/ 8/67 25MM.	16/ 9/67 25MM.	
2/ 4/68 10MM. *12/ 4/68 10MM. *26/ 4/68 10MM.	21/ 5/68 10MM. 28/ 5/68 10MM. 31/ 5/68 10MM.	3/ 6/68 10MM. 10/ 6/68 10MM.		4/ 8/68 25MM.		
*19/ 4/69 10MM.		8/ 6/69 10MM. 10/ 6/69 10MM.	16/ 7/69 25MM.	28/ 8/69 25MM.	22/ 9/69 25MM.	
*24/ 4/70 10MM.	3/ 5/70 10MM. 6/ 5/70 10MM. 13/ 5/70 10MM. 16/ 5/70 10MM. 20/ 5/70 10MM. 23/ 5/70 10MM. 25/ 5/70 10MM.	3/ 6/70 10MM. 6/ 6/70 10MM. 9/ 6/70 10MM.	10/ 7/70 25MM.	5/ 8/70 25MM.	7/ 9/70 25MM. 26/ 9/70 25MM.	

Individual dates of application (see Section 3(i))

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	28/ 5/70 10MM. 31/ 5/70 10MM.					
14/ 4/71 10MM. 20/ 4/71 10MM.	2/ 5/71 10MM. 6/ 5/71 10MM. 11/ 5/71 10MM. 17/ 5/71 10MM. 20/ 5/71 10MM.	6/ 6/71 10MM.	17/ 7/71 25MM. 29/ 7/71 25MM.		1/ 9/71 25MM. 12/ 9/71 25MM.	
23/ 4/72 10MM.	2/ 5/72 10MM. 22/ 5/72 10MM.		19/ 7/72 25MM.	15/ 8/72 25MM. 24/ 8/72 25MM.	4/ 9/72 25MM.	
15/ 4/73 10MM. 29/ 4/73 10MM.	18/ 5/73 10MM.	1/ 6/73 10MM. 5/ 6/73 10MM. 8/ 6/73 10MM.		8/ 8/73 25MM. 16/ 8/73 25MM.	4/ 9/73 25MM.	
8/ 4/74 10MM. 20/ 4/74 10MM. 29/ 4/74 10MM.	6/ 5/74 10MM. 15/ 5/74 10MM. 19/ 5/74 10MM. 26/ 5/74 10MM. 29/ 5/74 10MM.	2/ 6/74 10MM. 4/ 6/74 10MM.	24/ 7/74 25MM.	23/ 8/74 25MM.		
	6/ 5/75 10MM. 24/ 5/75 10MM. 29/ 5/75 10MM.	6/ 6/75 10MM. 9/ 6/75 10MM.	25/ 7/75 25MM. 30/ 7/75 25MM.	6/ 8/75 25MM. 11/ 8/75 25MM. 24/ 8/75 25MM.	4/ 9/75 25MM.	
10/ 4/76 10MM. 22/ 4/76 10MM. 28/ 4/76 10MM.	8/ 5/76 10MM. 15/ 5/76 10MM. 18/ 5/76 10MM. 24/ 5/76 10MM.	6/ 6/76 10MM. 8/ 6/76 10MM. 10/ 6/76 10MM.	10/ 7/76 25MM. 23/ 7/76 25MM.	2/ 8/76 25MM. 10/ 8/76 25MM. 17/ 8/76 25MM. 24/ 8/76 25MM.	8/ 9/76 25MM.	
15/ 4/77 10MM.	19/ 5/77 10MM. 21/ 5/77 10MM. 24/ 5/77 10MM. 27/ 5/77 10MM. 30/ 5/77 10MM.	2/ 6/77 10MM. 8/ 6/77 10MM.	20/ 7/77 25MM.		17/ 9/77 25MM.	
	17/ 5/78 10MM. 21/ 5/78 10MM. 25/ 5/78 10MM. 28/ 5/78 10MM. 31/ 5/78 10MM.	2/ 6/78 10MM. 5/ 6/78 10MM.		29/ 8/78 25MM.	17/ 9/78 25MM.	
21/ 4/79 10MM.	14/ 5/79 10MM. 17/ 5/79 10MM.	5/ 6/79 10MM. 9/ 6/79 10MM.	10/ 7/79 25MM. 22/ 7/79 25MM.	2/ 8/79 25MM.	6/ 9/79 25MM. 16/ 9/79 25MM.	
13/ 4/80 10MM. 18/ 4/80 10MM. 25/ 4/80 10MM.	4/ 5/80 10MM. 9/ 5/80 10MM. 12/ 5/80 10MM. 15/ 5/80 10MM. 17/ 5/80 10MM. 24/ 5/80 10MM.	5/ 6/80 10MM. 8/ 6/80 10MM.	31/ 7/80 25MM.	28/ 8/80 25MM.	14/ 9/80 25MM.	

FIELD BY HEN HOUSE

NO.OF TIMES A GIVEN INTERVAL BETWEEN APPLICATIONS OCCURS

YEAR	INTERVAL(DAYS)							
	1-4	5	6	7	8	9	10	11+
1961	6	2	0	0	0	0	0	2
1962	3	2	0	0	1	0	0	3
1963	6	0	0	3	0	0	1	1
1964	6	1	0	0	0	1	1	3
1965	3	0	0	1	1	0	0	2
1966	5	0	1	1	0	0	0	2
1967	2	0	0	0	0	0	0	6
1968	2	0	0	2	0	0	1	3
1969	1	0	0	0	0	0	0	4
1970	10	0	0	1	0	1	0	4
1971	2	1	2	0	0	0	0	6
1972	0	0	0	0	0	2	0	4
1973	2	0	0	0	1	0	0	5
1974	4	0	0	2	0	2	0	3
1975	1	3	0	1	1	0	0	4
1976	3	0	2	3	1	0	2	5
1977	5	0	1	0	0	0	0	3
1978	6	0	0	0	0	0	0	2
1979	2	0	0	0	0	0	1	6
1980	4	2	0	2	0	1	0	4

Frequency Distribution
(see Section 3(iii))

The 2nd Field is now treated in a similar way to the 1st Field

FIELD BY DUCK POND

YEAR	TOTAL WATER(MM)	TOTAL WATER(ML)	FIRST APPLICATION	LAST APPLICATION	NO.OF APPLICATIONS	MIN.PERIOD(DAYS)	CROP	RUN OFF(MM) APR TO SEPT
1961	150	15.00	19/ 5	31/ 7	6	6	SUGAR BEET	23
1962	150	15.00	17/ 5	13/ 7	6	6	SUGAR BEET	17
1963	125	12.50	18/ 5	31/ 7	5	9	SUGAR BEET	74
1964	125	12.50	15/ 5	29/ 7	5	12	SUGAR BEET	8
1965	100	10.00	1/ 5	9/ 7	4	20	SUGAR BEET	68
1966	75	7.50	30/ 5	14/ 7	3	11	SUGAR BEET	54
1967	125	12.50	10/ 6	23/ 7	5	7	SUGAR BEET	75
1968	50	5.00	2/ 6	16/ 6	2	14	SUGAR BEET	182
1969	100	10.00	14/ 6	21/ 7	4	7	SUGAR BEET	88
1970	175	17.50	14/ 5	21/ 7	7	8	SUGAR BEET	51
1971	100	10.00	18/ 5	24/ 7	4	8	SUGAR BEET	43
1972	100	10.00	11/ 7	29/ 8	3	8	SUGAR BEET	13
1973	100	10.00	8/ 6	23/ 8	3	8	SUGAR BEET	85
1974	100	10.00	16/ 5	29/ 7	4	8	SUGAR BEET	26
1975	175	17.50	7/ 6	8/ 8	6	6	SUGAR BEET	31
1976	300	30.00	16/ 5	26/ 8	10	4	SUGAR BEET	43
1977	125	12.50	25/ 5	28/ 7	5	10	SUGAR BEET	22
1978	75	7.50	26/ 5	26/ 7	3	10	SUGAR BEET	111
1979	125	12.50	17/ 6	22/ 7	5	7	SUGAR BEET	30
1980	50	5.00	8/ 5	17/ 5	2	9	SUGAR BEET	57

(year by year breakdown)

FIELD BY DUCK POND

APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OTHER
	19/ 5/61 25MM.	3/ 6/61 25MM. 15/ 6/61 25MM. 22/ 6/61 25MM. 28/ 6/61 25MM.	31/ 7/61 25MM.			
	17/ 5/62 25MM.	8/ 6/62 25MM. 16/ 6/62 25MM. 23/ 6/62 25MM. 29/ 6/62 25MM.	13/ 7/62 25MM.			
	18/ 5/63 25MM.	3/ 6/63 25MM. 22/ 6/63 25MM.	22/ 7/63 25MM. 31/ 7/63 25MM.			
	15/ 5/64 25MM. 27/ 5/64 25MM.	30/ 6/64 25MM.	16/ 7/64 25MM. 29/ 7/64 25MM.			
	1/ 5/65 25MM. 25/ 5/65 25MM.	19/ 6/65 25MM.	9/ 7/65 25MM.			
	30/ 5/66 25MM.	10/ 6/66 25MM.	14/ 7/66 25MM.			
		10/ 6/67 25MM. 18/ 6/67 25MM.	8/ 7/67 25MM. 15/ 7/67 25MM. 23/ 7/67 25MM.			
		2/ 6/68 25MM. 16/ 6/68 25MM.				
		14/ 6/69 25MM.	4/ 7/69 25MM. 14/ 7/69 25MM. 21/ 7/69 25MM.			
	14/ 5/70 25MM. 25/ 5/70 25MM.	4/ 6/70 25MM. 13/ 6/70 25MM. 21/ 6/70 25MM.	7/ 7/70 25MM. 21/ 7/70 25MM.			
	18/ 5/71 25MM.		7/ 7/71 25MM. 16/ 7/71 25MM. 24/ 7/71 25MM.			
			11/ 7/72 25MM. 19/ 7/72 25MM.	29/ 8/72 50MM.		
		8/ 6/73 25MM. 16/ 6/73 25MM.		23/ 8/73 50MM.		
	16/ 5/74 25MM.	1/ 6/74 25MM.	21/ 7/74 25MM. 29/ 7/74 25MM.			
		7/ 6/75 25MM. 20/ 6/75 25MM. 26/ 6/75 25MM.	6/ 7/75 25MM. 28/ 7/75 25MM.	8/ 8/75 50MM.		
	16/ 5/76 25MM.	10/ 6/76 25MM. 22/ 6/76 25MM. 26/ 6/76 25MM.	3/ 7/76 25MM. 8/ 7/76 25MM. 17/ 7/76 25MM. 27/ 7/76 25MM.	13/ 8/76 50MM. 26/ 8/76 50MM.		

(individual dates)

	25/ 5/77 25MM.	8/ 6/77 25MM.	4/ 7/77 25MM. 14/ 7/77 25MM. 28/ 7/77 25MM.			
	26/ 5/78 25MM.	5/ 6/78 25MM.	26/ 7/78 25MM.			
		17/ 6/79 25MM. 27/ 6/79 25MM.	7/ 7/79 25MM. 15/ 7/79 25MM. 22/ 7/79 25MM.			
	8/ 5/80 25MM. 17/ 5/80 25MM.					

FIELD BY DUCK POND

NO.OF TIMES A GIVEN INTERVAL BETWEEN APPLICATIONS OCCURS

YEAR	INTERVAL(DAYS)							
	1-4	5	6	7	8	9	10	11+
1961	0	0	1	1	0	0	0	3
1962	0	0	1	1	1	0	0	2
1963	0	0	0	0	0	1	0	3
1964	0	0	0	0	0	0	0	4
1965	0	0	0	0	0	0	0	3
1966	0	0	0	0	0	0	0	2
1967	0	0	0	1	2	0	0	1
1968	0	0	0	0	0	0	0	1
1969	0	0	0	1	0	0	1	1
1970	0	0	0	0	1	1	1	3
1971	0	0	0	0	1	1	0	1
1972	0	0	0	0	1	0	0	1
1973	0	0	0	0	1	0	0	1
1974	0	0	0	0	1	0	0	2
1975	0	0	1	0	0	0	1	3
1976	1	1	0	1	0	1	1	4
1977	0	0	0	0	0	0	1	3
1978	0	0	0	0	0	0	1	1
1979	0	0	0	1	1	0	2	0
1980	0	0	0	0	0	1	0	0

frequency distribution

SUMMARY TABLE GIVING THE IRRIGATION WATER APPLIED EACH MONTH IN MILLIONS OF LITRES

	FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5	FIELD 6	FIELD 7	FIELD 8	FIELD 9	FIELD10	FIELD11	FIELD12	FIELD13	FIELD14	ALL FIELDS
APRL 1961	0.0	0.0													0.0
MAY 1961	15.00	2.50													17.5
JUNE 1961	7.50	10.00													17.5
JULY 1961	6.25	2.50													8.8
AUG 1961	6.25	0.0													6.3
SEPT 1961	0.0	0.0													0.0
REST 1961	0.0	0.0													0.0
APRL 1962	2.50	0.0													2.5
MAY 1962	10.00	2.50													12.5
JUNE 1962	7.50	10.00													17.5
JULY 1962	6.25	2.50													8.8
AUG 1962	6.25	0.0													6.3
SEPT 1962	0.0	0.0													0.0
REST 1962	0.0	0.0													0.0
APRL 1963	2.50	0.0													2.5
MAY 1963	15.00	2.50													17.5
JUNE 1963	7.50	5.00													12.5
JULY 1963	6.25	5.00													11.3
AUG 1963	6.25	0.0													6.3
SEPT 1963	0.0	0.0													0.0
REST 1963	0.0	0.0													0.0
APRL 1964	0.0	0.0													0.0
MAY 1964	20.00	5.00													25.0
JUNE 1964	0.0	2.50													2.5
JULY 1964	6.25	5.00													11.3
AUG 1964	12.50	0.0													12.5
SEPT 1964	12.50	0.0													12.5
REST 1964	0.0	0.0													0.0
APRL 1965	2.50	0.0													2.5
MAY 1965	12.50	5.00													17.5
JUNE 1965	2.50	2.50													5.0
JULY 1965	0.0	2.50													2.5
AUG 1965	6.25	0.0													6.3
SEPT 1965	0.0	0.0													0.0
REST 1965	0.0	0.0													0.0
APRL 1966	2.50	0.0													2.5
MAY 1966	12.50	2.50													15.0
JUNE 1966	7.50	2.50													10.0
JULY 1966	0.0	2.50													2.5
AUG 1966	0.0	0.0													0.0
SEPT 1966	6.25	0.0													6.3
REST 1966	0.0	0.0													0.0

monthly totals of the water requirement (see Section 3(iv))

APRL 1967	5.00	0.0	5.0
MAY 1967	0.0	0.0	0.0
JUNE 1967	7.50	5.00	12.5
JULY 1967	12.50	7.50	20.0
AUG 1967	6.25	0.0	6.3
SEPT 1967	6.25	0.0	6.3
REST 1967	0.0	0.0	0.0
APRL 1968	7.50	0.0	7.5
MAY 1968	7.50	0.0	7.5
JUNE 1968	5.00	5.00	10.0
JULY 1968	0.0	0.0	0.0
AUG 1968	6.25	0.0	6.3
SEPT 1968	0.0	0.0	0.0
REST 1968	0.0	0.0	0.0
APRL 1969	2.50	0.0	2.5
MAY 1969	0.0	0.0	0.0
JUNE 1969	5.00	2.50	7.5
JULY 1969	6.25	7.50	13.8
AUG 1969	6.25	0.0	6.3
SEPT 1969	6.25	0.0	6.3
REST 1969	0.0	0.0	0.0
APRL 1970	2.50	0.0	2.5
MAY 1970	22.50	5.00	27.5
JUNE 1970	7.50	7.50	15.0
JULY 1970	6.25	5.00	11.3
AUG 1970	6.25	0.0	6.3
SEPT 1970	12.50	0.0	12.5
REST 1970	0.0	0.0	0.0
APRL 1971	5.00	0.0	5.0
MAY 1971	12.50	2.50	15.0
JUNE 1971	2.50	0.0	2.5
JULY 1971	12.50	7.50	20.0
AUG 1971	0.0	0.0	0.0
SEPT 1971	12.50	0.0	12.5
REST 1971	0.0	0.0	0.0
APRL 1972	2.50	0.0	2.5
MAY 1972	5.00	0.0	5.0
JUNE 1972	0.0	0.0	0.0
JULY 1972	6.25	5.00	11.3
AUG 1972	12.50	5.00	17.5
SEPT 1972	6.25	0.0	6.3
REST 1972	0.0	0.0	0.0
APRL 1973	5.00	0.0	5.0
MAY 1973	2.50	0.0	2.5
JUNE 1973	7.50	5.00	12.5
JULY 1973	0.0	0.0	0.0
AUG 1973	12.50	5.00	17.5
SEPT 197_	6.25	0.0	6.3
REST 1973	0.0	0.0	0.0
APRL 1974	7.50	0.0	7.5
MAY 1974	12.50	2.50	15.0
JUNE 1974	5.00	2.50	7.5

JULY 1974	6.25	5.00	11.3
AUG 1974	6.25	0.0	6.3
SEPT 1974	0.0	0.0	0.0
REST 1974	0.0	0.0	0.0
APRL 1975	0.0	0.0	0.0
MAY 1975	7.50	0.0	7.5
JUNE 1975	5.00	7.50	12.5
JULY 1975	12.50	5.00	17.5
AUG 1975	18.75	5.00	23.8
SEPT 1975	6.25	0.0	6.3
REST 1975	0.0	0.0	0.0
APRL 1976	7.50	0.0	7.5
MAY 1976	10.00	2.50	12.5
JUNE 1976	7.50	7.50	15.0
JULY 1976	12.50	10.00	22.5
AUG 1976	25.00	10.00	35.0
SEPT 1976	6.25	0.0	6.3
REST 1976	0.0	0.0	0.0
APRL 1977	2.50	0.0	2.5
MAY 1977	12.50	2.50	15.0
JUNE 1977	5.00	2.50	7.5
JULY 1977	6.25	7.50	13.8
AUG 1977	0.0	0.0	0.0
SEPT 1977	6.25	0.0	6.3
REST 1977	0.0	0.0	0.0
APRL 1978	0.0	0.0	0.0
MAY 1978	12.50	2.50	15.0
JUNE 1978	5.00	2.50	7.5
JULY 1978	0.0	2.50	2.5
AUG 1978	6.25	0.0	6.3
SEPT 1978	6.25	0.0	6.3
REST 1978	0.0	0.0	0.0
APRL 1979	2.50	0.0	2.5
MAY 1979	5.00	0.0	5.0
JUNE 1979	5.00	5.00	10.0
JULY 1979	12.50	7.50	20.0
AUG 1979	6.25	0.0	6.3
SEPT 1979	12.50	0.0	12.5
REST 1979	0.0	0.0	0.0
APRL 1980	7.50	0.0	7.5
MAY 1980	15.00	5.00	20.0
JUNE 1980	5.00	0.0	5.0
JULY 1980	6.25	0.0	6.3
AUG 1980	6.25	0.0	6.3
SEPT 1980	6.25	0.0	6.3
REST 1980	0.0	0.0	0.0

SUMMARY TABLE GIVING THE IRRIGATION WATER APPLIED EACH YEAR IN MILLIONS OF LITRES

	FIELD 1	FIELD 2	FIELD 3	FIELD 4	FIELD 5	FIELD 6	FIELD 7	FIELD 8	FIELD 9	FIELD10	FIELD11	FIELD12	FIELD13	FIELD14	ALL FIELDS
1961	35.00	15.00													50.0
1962	32.50	15.00													47.5
1963	37.50	12.50													50.0
1964	51.25	12.50													63.8
1965	23.75	10.00													33.8
1966	28.75	7.50													36.3
1967	37.50	12.50													50.0
1968	26.25	5.00													31.3
1969	26.25	10.00													36.3
1970	57.50	17.50													75.0
1971	45.00	10.00													55.0
1972	32.50	10.00													42.5
1973	33.75	10.00													43.8
1974	37.50	10.00													47.5
1975	50.00	17.50													67.5
1976	68.75	30.00													98.8
1977	32.50	12.50													45.0
1978	30.00	7.50													37.5
1979	43.75	12.50													56.3
1980	46.25	5.00													51.3
TOTAL	776.25	242.50													1018.7

yearly totals of the water requirement (see Section 3(v))